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Editorial

User decision-making and technology choices in the U.S. carsharing market

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ABSTRACT

Each time a user of a carsharing service reserves a vehicle they choose from a selection of vehicles that vary in attributes including rental price, the distance of the vehicle from their current location, the availability of the vehicle at their desired reservation time, and the type of vehicle (e.g., gasoline, Hybrid, Plug-in Hybrid or Electric). In this paper we analyze the results of a discrete choice survey administered to members of a leading North American carsharing organization. We quantify how carsharing users value price, distance from them, schedule and vehicle type. We find that for an average user, traveling one mile for a vehicle or rescheduling a trip by up to one hour are each approximately equivalent to a US $2/hour increase in vehicle price. We find that carsharing acts as a conduit to introduce users to new vehicle technology: more than half users report having driven a Hybrid vehicle through carsharing, representing 400 users exposed for every one Hybrid vehicle in service. All else being equal, users most prefer Hybrid vehicles. Users who report driving longer distances prefer not to take either electric vehicles or Plug-in Hybrids, despite the fact that Plug-in Hybrids do not have significant range limitations.
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1. Introduction

The U.S. market for carsharing has grown steadily over the past decade, with more than one million users renting vehicles on a short-term basis from 23 operators (Shaheen and Cohen, 2014). In this study we focus on round-trip carsharing, a shared-use model in which users rent cars for increments of one hour and up, returning the vehicle to the original pick up location at the end of their rental. In such services, users commonly choose from a range of available vehicles when they make a reservation, trading off a range of attributes including the hourly price of the vehicle, the distance they must travel to access the vehicle, and the time the vehicle is available. For example, a user may have to choose between the vehicle they want that is only available at a time later than they desire, or a vehicle that is available at the time requested but further away. They also may select from different makes and models of cars and trucks, including options that have different passenger and cargo capacities. From a technology perspective, members of round-trip carsharing services have been able to choose from a wide range of gasoline and Hybrid-Electric Vehicles (HEVs) for many years. More recently, advanced technologies including Plug-in Hybrid-Electric Vehicles (PHEVs) and Battery-Electric Vehicles (BEVs) have been introduced into some carsharing fleets, incentivized in California with the ability to earn bonus credits under the Zero Emissions Vehicle (ZEV) mandate (CARB, 2012).

Understanding how carsharing users make decisions about which shared vehicle they will reserve, if any, is essential for the effective management of carsharing services and the overall appeal of carsharing relative to other transportation modes. The emerging literature on carsharing has considered a range of issues including the demographics of carsharing users, factors influencing the success of carsharing schemes, the impact of carsharing on vehicle ownership and vehicle miles traveled (VMT), and the relationship between carsharing and other transportation modes. In particular, several papers have investigated factors that contribute to overall levels of carsharing usage. Stillwater et al. (2009) investigate the attributes of the urban environment that influence the usage rates of carsharing vehicles, using aggregate reservation data from a single carsharing service. Barnes and Rutherford (2001) use a logit model to estimate the influence of various carsharing service attributes on the likelihood of prospective members joining carsharing. Membership fees and usage fees are found to be important, but access distance and reserve time were not found to be significant. Cervero et al. (2006) surveyed City

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CarShare users in San Francisco, finding that car type was an important factor in vehicle choice for more than half of the users surveyed. Catalano et al. (2008) surveyed travelers in Palermo, Italy, about travel preferences and mode choice (including carsharing) as a function of cost and time. More recently, de Lorimier and El-Geneidy (2013) used a regression approach, finding that vehicle age and proximity to users are important decision factors. However, the carsharing literature has not yet considered reservation decision-making from the perspective of individual users, capturing the influence of operational attributes such as the location of the vehicle relative to the user, and the availability of the vehicle at the time desired by the user.

In contrast with the extensive literature on consumer purchasing of alternative fuel vehicles in the light duty vehicle fleet (reviewed by Al-Alawi and Bradley (2013)), little has been written about the role of vehicle powertrain technologies in the carsharing context. An early study by Rutherford (2003) noted that vehicles in the Flexcar program were at the time 50% more fuel-efficient than the average new vehicle sold in the U.S., and management explicitly stated a goal of incorporating alternative fuel vehicles. In Europe carsharing operators incorporated electric vehicles as early as the 1970 s and several EV-based sharing systems (e.g., Car2Go, Autolib) are in operation today. However, these systems are typically based on a single vehicle type and consumers simply choose the closest available vehicle, simplifying the vehicle choice decision. The re-introduction of PHEVs and BEVs into the U.S. market by automakers in late-2010 has provided the opportunity to deploy these alternative fuel vehicles in carsharing fleets. Le Vine et al. (2014) incorporate vehicle type as a variable in their model of traveler behavior but do not find it to be statistically significant. According to a tweet from the CarSharing Association's conference in September, 2013 “RT @AutoShare: Half the people in San Francisco Bay Area who have driven electric cars did so thru @CityCarShare. #carsharing13.” This anecdote suggests a potentially important role for carsharing in the broader adoption of alternative fuel vehicles in the U.S. light duty vehicle fleet, providing opportunities for drivers to readily trial new technologies and observe new technologies in use, key determinants of the rate of technology adoption (Rogers, 2003).

With this study we aim to make two contributions to emerging literature on carsharing, and shared-use mobility services more broadly. First, we seek to understand the relative importance carsharing users place on key carsharing service attributes such as price, distance, vehicle type and time. Second, given the increasing interest in carsharing applications for alternative fuel vehicles, we investigate both the willingness of users to drive Hybrid-Electric (HEV), Plug-in Hybrid-Electric (PHEV) and Battery-Electric Vehicles (BEV), and the rate of exposure of carsharing users to new vehicle technologies through carsharing. We use a discrete-choice approach to model the decisions that carsharing members make when selecting a vehicle for rental, estimating models using survey data collected from members of Zipcar, the largest U.S. carsharing organization.

The paper is organized as follows: In Section 2, we describe our approach involving discrete choice analysis of survey responses. We describe the characteristics of the sample population in Section 3, and present the results of the discrete choice analysis in Section 4. Finally, we close in Section 5 with discussion of the implications of our research, limitations and future research opportunities.

2. Approach

Our data were collected through an online survey of members of the largest carsharing operator in North America, Zipcar, conducted in October 2013. Previous surveys undertaken by the carsharing operator asked members to describe their rental preferences, finding that the top three factors influencing users' vehicle reservation decisions were price, proximity and availability. While environmental impact did not rank highly as a motivation for selecting a particular vehicle, most respondents indicated that they were either ‘interested’ or ‘extremely interested’ in electric vehicles. We use these anecdotes to develop a stated-preference approach in which the effect of service attributes and vehicle technology are explored concurrently.

To deploy our survey, the carsharing provider sent an email to 68,982 randomly selected members, inviting them to participate in our survey with the incentive of a chance to win $50 in free driving credit for their completed response. 4673 unique respondents (6.8%) began the survey, 4133 (6.0%) completed most demographic information and 3958 (5.7%) completed at least a portion of the discrete choice experiment. The survey consisted of three sections. The first section asked the respondent to provide demographic information, estimates of their typical reservation behavior (how frequently, how long, and how far they drive), and information about their public transit usage. Respondents were also asked questions about their experience with Hybrid, Plug-in Hybrid and Electric Vehicles, to introduce the respondent to these terms and gather information about respondent exposure to these technologies. For example:

Some Zipcars are Hybrids (*e.g. Toyota Prius*). *Hybrids run on gasoline, but use batteries and an electric motor to reduce the amount of gasoline the car uses. Have you ever driven a Hybrid*?

- *Yes, I own* (*or previously owned*) *a Hybrid.*
- *Yes, I've driven a Zipcar Hybrid.*
- *Yes, I've driven a Hybrid elsewhere.*
- *No, I haven't driven a Hybrid.*
- *I'm not sure.*

In the second section of the survey, each respondent was presented with a discrete choice experiment in which they were asked to select the vehicle they would reserve for their typical carsharing trip. Each respondent was asked to complete four choice panels, comprising four available vehicle choices and a ‘none of the above’ alternative. The choices offered in each panel varied along four attributes: the distance of the vehicle from the respondent (hereby referred to as ‘Access Distance’), the hourly rental price, the time the vehicle is available relative to the respondents preferred reservation time, and the vehicle fuel type. Rather than presenting vehicle type as a specific vehicle make/model, which typically conflates numerous product attributes (e.g., quality, styling and brand image), the vehicle attribute was presented to users as ‘fuel type’ with the options of Hybrid, Plug-In Hybrid (30-mile electric range plus gasoline), and Electric Vehicle (100 mile range) (Table 1).

Unlike some one-way carsharing schemes, round trip carsharing users can typically book well in advance of their trip. If no desired vehicles are available at their preferred reservation time, users can see when vehicles are booked and adjust their schedules to a time when a suitable vehicle is available. A user adjusting his or her schedule could theoretically happen in many ways, such as undertaking the trip at a different time or truncating their trip to fit with vehicle availability. We presented users with a simplified version of schedule adjustments: either a vehicle was available “Exactly when I want it” or as a difference from their preferred time of 30 min, 1 h or 2 h earlier or later. An example panel is shown in Fig. 1.

The levels used for each attribute in the discrete choice experiment are shown in Table 1, again selected to be representative of the actual levels commonly offered to carsharing users.